

Remarks/Arguments:

The election of claims 1 – 15 for examination is affirmed. The Examiner's Telephonic Interview Summary provided with the Action is correct. Claims 16 – 18 are cancelled and it is Applicant's present intention to include same in a divisional application.

The specification is amended at page 12 to further describe the FIG. 2 hole (PTH 11) as extending entirely though the board (10) and, significantly, not including plating to the extent that the plating entirely fills the hole. This is also understood from the preceding description on page 10 (lines 1-5) in which plating thicknesses and associated hole diameters are expressly defined. It is clearly understood from said thicknesses and diameters that the plated metal cannot completely fill the hole. The hole (11) shown in FIG. 2 thus includes an opening therein (at the center, as shown) which extends through the board thickness as well. Support fully provided, entry is urged.

Claims 1-18 are cancelled (claims 16-18 in response to the restriction requirement) and new claims 19-38 added. New independent claim 19 defines the invention in further detail and in a manner which is patentably distinguishable over the documents of record herein, especially Hey and Tsuchida. Specifically, method claim 19 defines the plating of a hole which extends entirely though the thickness of a printed circuit board. Support is provided at page 8, lines 10-12 (for printed circuit board) and at FIG.2 page 11, line 23 (for a hole which extends entirely though the board). Claim 19 further defines the plating as being a substantially uniform layer of said metal on said internal surface of said hole which does not fill said hole with said metal. Support is also shown in FIG. 2 (hole 11 is clearly seen as not filled). As stated above, the specification is also amended at page 12 to provide the specific wording for claim 19. Of great significance, claim 19 defines the plating occurring within such holes wherein the aspect ratio of the thickness of the printed circuit board to the hole diameter is from 10:1 to 25:1. Support is found at page 3, line 23. Support is also found at page 4 (top) where three specific examples show aspect ratios of 14.62:1 (380 mils:26 mils) , 16.25:1 (260 mils:16 mils) and 21:1 (210 mils:10 mils). These aspect ratios are considered very important considering the fact that Applicant is plating holes which extend through the board entirely with uniform plating thicknesses, avoiding the pitfalls (e.g., thin or no middle plating in the hole) mentioned in the specification at page 5, lines 16-21. Claim 19 also defines the pulse durations of the modulated forward pulses as being from about 40 to 140 milliseconds, the modulated reverse pulses as being from about 2 to about 8 milliseconds, and the pause in current for a duration of about 0.1 to about 1.0 millisecond. This is also considered especially significant because the application of such

relatively short modulated forward pulses, followed by such short pauses in current, is desirable and considered entirely unexpected in order to obtain successful platings within holes extending through a board at the aspect ratios now defined. Finally, claim 19 defines the pause in current as occurring following the modulated reverse pulse. Support is in the previous claim 1.

The dependent claims 20-28 find support in the previous dependent claims, but now depend directly or indirectly from new independent claim 19.

New independent claim 29 includes similar limitations as in new claim 19 but defines the pause as occurring following the modulated forward pulse and prior to the following modulated reverse pulse. Support is found in previous claim 1, but most specifically at page 9, lines 7-11. Dependent claims 30-38 find support in the previous dependent claims, and depend directly or indirectly from new independent claim 29.

Support being fully provided for all of the limitations found in the new claims submitted herewith, these new limitations do not constitute new matter and entry is respectfully urged.

The invention as defined by new independent claims 19 and 29 is deemed to be patentably distinguishable over the documents of record in the application and particularly the patents to Hey and Tsuchida. The rejections under 35 USC 102 and 35 USC 103 based on these documents are deemed overcome and withdrawal thereof urged.

Hey does not teach plating so as to leave an opening entirely through the resulting hole structure, a key aspect of the claimed invention. Hey is concerned only with filling his "trenches" or his partial depth "vias" to prevent "voids" therein as shown in his prior art FIG. 2. See col. 4, line 18, col. 5, lines 41 and 42, and col. 7, line 16. He also requires a gradual decrease in pulses to accomplish this, something Applicant's claimed invention does not do, and indicates such decreases are instrumental in accomplishing the fill operations. See col. 3, lines 43-49. Hey also requires forward pulses of much greater duration (500 – 3000 milliseconds) than Applicant's claimed pulses, thus requiring greater time to accomplish his platings, an undesirable aspect overcome by Applicant. Of perhaps the most significance, Hey does not teach or suggest plating holes with board thickness to hole diameter aspect ratios claimed by Applicant. Hey instead mentions the particular difficulty when attempting to plate at aspect ratios greater than 10:1 (col. 1, line 28) and then mentions the need to stay at lower ratios, particularly as low as 4:1.

Col. 1, line 33. Hey thus fails to teach or suggest the instantly claimed invention and any rejections based thereon are in error. Withdrawal thereof is again urged.

Tsuchida also fails to teach or suggest the claimed invention. Tsuchida, like Hey, only discusses partial depth holes, not plating of holes which extend entirely through a substrate. Even with such partial depth holes, Tsuchida mentions that a hole only partly plated is inadequate. See his FIG. 1 partly plated hole and his comments in para. 0090. Equally significant, Tsuchida requires “dummy electrolysis” in order to fill his holes. Para. 0090. Applicant’s claimed invention of claims 19 and 29 do not require this limitation, nor is same desired. Even further, Tsuchida fails to mention aspect ratios for his final structures. Absent such discussion, he inherently fails to teach or suggest the relatively high aspect ratios taught and now claimed by Applicant. Tsuchida admittedly describes forward pulse applications of 1-40 milliseconds, as mentioned by the Examiner, but this range is much less than the now claimed range of 40-140 milliseconds. Tsuchida’s reverse pulse range (0.2 to 5 milliseconds) is also less than Applicant’s claimed range of 2 to 8 milliseconds. Understandably, Applicant’s higher durations for both forward and reverse pulse application is a significant part of assuring the proper plating thickness for his hole, but not high enough to result in the filling of said holes, while significantly assuring the now claimed relatively high aspect ratios. Even further, Tsuchida does mention a pause (para. 0067), but appears to do so only as a minor afterthought, because he fails to mention a time duration which such a pause can occur. Tsuchida, like Hey, thus fails to teach or suggest the instantly claimed invention and any rejections based thereon are improper under both 35 USC 102 and 35 USC 103. Withdrawal thereof is again urged.

With particular regard to new independent claim 29, neither Hey nor Tsuchida suggest pausing the current following a forward pulse and prior to the following reverse pulse. The invention defined by claim 29 is deemed particularly distinguishable.

Bernards has also been carefully reviewed. Admittedly, this patent discusses plating holes in printed circuit boards (which Applicant has admitted is known, e.g., page 3) and even in using copper plating baths for this purpose (something Applicant also acknowledges is known, e.g., page 4). Bernards also discusses aspect ratios greater than 10:1, one example being as high as 18:1 (col. 8, line 24). However, nowhere does Bernards suggest using forward and reverse pulsing in combination with pauses either after the forward or the reverse pulses, to achieve uniform plating at such aspect ratios. He thus inherently fails to teach dual pulse and singular pause durations as now claimed. Combining Bernards with Hey, as applied by the Examiner, will thus fail to suggest the claimed invention. The only possible

result of any such combination would be the complete filling of trenches or partial depth holes with significantly large duration (500-3000 milliseconds) current in order to fill said trenches or holes. Such would not result in holes plated only on the walls thereof and not completely filled as defined by the method of claim 19 now presented. Bernards thus fails to suggest the claimed invention and a rejection based thereon is improper. Withdrawal of said rejection is urged.

Sonnenberg has also been carefully reviewed. This patent, like the three above, lacks the requisite suggestiveness to one of ordinary skill in the art to derive the now claimed invention. Like Bernards, Sonnenberg fails to discuss dual pulse and pause applications for his plating baths. He does discuss plating holes in printed circuit boards with copper plating solutions, and aspect ratios greater than 10:1, all of which are known. Because he fails to mention forward and reverse pulsing, and the application of a pause following either pulse, Sonnenberg does not provide requisite suggestion to modify Hey or Bernards (as combined by the Examiner) to the level to reach the claimed invention. Even if so, however, the resulting combination would not be the unique method claimed. The rejection based on this patent and the other two must therefore be withdrawn.

The secondary documents of Simpson, Dahms and Lopatin, cited but not applied by the Examiner against the claims, also lack sufficient teachings to teach or suggest the claimed invention, including if taken in combination with one or more of the foregoing documents. Simpson and Lopatin, for example, like Hey, appear only to discuss "trench filling."

None of the cited patents being capable of teaching or suggesting (if combined in any manner) the presently claimed invention, any rejections under 35 USC 102 or 35 USC 103 based thereon are improper. This applies equally well for any rejections of the dependent claims now added. Said claims depend directly or indirectly from subject matter which is considered fully distinguishable over the cited documents, and are similarly viewed. Withdrawal of all rejections of said dependent claims is likewise urged.

Allowance of the claims remaining in this application is respectfully requested.

The Application is deemed in condition for allowance, and such action on the part of the Examiner is respectfully urged. Should the Examiner believe, however, that minor differences may remain which, if overcome, will result in allowance of this Application and that said differences may be openly discussed in a telephone conversation, the Examiner is respectfully requested to phone the undersigned to discuss such differences and hopefully resolve same, thereby expediting prosecution of this Application.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Lawrence R. Fraley", written in a cursive style.

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